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WHAT MATHEMATICAL SUBJECTS SHOULD BE INCLUDED IN THE CURRICULUM OF THE SECONDARY SCHOOLS.*

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(Continued from last issue.)

I wonder why this is so. However widely opinion may vary as to the value of the study of mathematics as an exercise of mind, surely the great majority of thoughtful persons will agree that arithmetic and algebra and geometry are great and powerful subjects, and that the study of some of these subjects ought to have a place in that limited but vital portion of a boy's education that is supplied by his scholastic training. It would seem too that the kind of training supplied by the study of mathematics is the kind peculiarly needed in youth. Probably few will claim that the elementary branches of mathematics deserve high rank among the studies that train the powers of observation, and develop the inquiring, acquisitive faculty, that cultivate the sense of perspective and discrimination, the power to weigh probabilities. Few would give them high place among the studies that make the mind copious, fertile, vivacious, alert, that cultivate the imagination, elevate the fancy, and enlarge the sympathies. I question whether, if rightly studied, they are of very great value in cultivating a vigorous and retentive memory. But as teaching the power of calm, steady and sustained attention, the acquisition of clear ideas, the habit of accurate and orderly thinking, they surely stand second to no subject now embraced in the curriculum of school or college.

And yet, I believe it to be the fact that nine boys out of ten derive very little useful mental training from the study of mathematics. Whatever benefit they derive from it consists solely, I believe, in a useful training in accuracy and in the wholesome discipline of applying themselves to a tedious and irksome task. Mathematics undoubtedly make for accuracy. Whether a boy scrapes through by an effort of sheer memory or whether he grasps enough of the technique of the subject to move mechanically through the formulæ to the conclusion (and few boys ever advance beyond one or the other of these methods), still he must be accurate and his conclusions must be correct throughout or his final conclusion will be wrong. And on the other point, it is surely a great gain to a man to learn early in life to set himself to a difficult and irksome task. Certainly he has small chance of success in any of the professions unless he learns sooner or later that day in and day out much of his work is drudgery, but that it must be done promptly, carefully and thoroughly. But for the rest, when you inquire as to the value of mathematics in teaching a boy to think, to reason upon principles and to understand them, to learn from mathematics the real nature and scope of demonstrative proof, the number of boys who derive any appreciable benefit in these lines from the study of mathematics is so small as to be a negligible quantity.

It seems to me that both the *amount* and *kind* of mathematics contained in the present school curriculum is based upon a very exaggerated estimate of a boy's mental capacity. Nothing is more difficult in youth than the acquisition of clear ideas, the power of attention and the habit of orderly logical reasoning. And in mathematics a boy's difficulties are increased tenfold by the abstract and highly technical nature of the subject. He must apply himself to a group of new and difficult conceptions expressed in a highly technical and entirely new and peculiar language. A real grasp of the principles of arithmetic is a task of supreme difficulty for a boy of fourteen years of age. And then too, the technique changes so quickly as he is rushed from one branch of the subject to another. He begins to study history at say eight or nine years of age and continues that subject throughout school and college. He deals throughout with the same language and with the same kind of ideas. But each branch of mathematics has, so to speak, a language all its own. At thirteen or fourteen the student is expected to have *learned* his arithmetic. He has, but he hasn't understood it. And so he is launched into algebra. A new language must be learned, a highly formal technique must be understood before he can begin to contemplate and reason upon and understand the principles of algebra. No doubt the simplest formulæ in algebra contain great principles and lessons and offer rich fields of benefit and pleasure to those who can and will explore them. But these treasures, like Nature's jewels, are lodged deep in the rocks and the seeker must break and dig and delve to find them. A child of fourteen reads in the introductory chapter of his School Algebra that he is now undertaking "the investigation of the fundamental laws of numbers" and that it is "*very important* that the *beginner* in algebra should have *clear ideas* of these laws and of the extended meaning which it is necessary to give in algebra to certain words and signs used in arithmetic, and that he should see that every such extension of meaning is consistent with the meaning previously attached to the word or sign and with the general laws of numbers." Do you suppose for a single moment that a normal boy of fourteen either can or will do such a thing? And when he tosses that book aside and pulls down Rob Roy or Treasure Island or grabs his hat and makes for the great out-of-doors, where lies the blame? With the boy? Or is it with the teacher who put that book in his hands? A very experienced teacher of mathematics told me not very long ago that in the average freshman class in college not a single student can explain *why it is* that $(-a) \times (-b) = +ab$. Now I have been told that this embodies one of the fundamental conceptions and laws of algebra, and as I find this formula on page 23 of the introductory chapter of my School Algebra, I presume that this is so, and that this is one of the things about which it is "very important that the beginner in algebra should have clear ideas." I venture the statement that the average well-trained, able and successful lawyer can spend a long and arduous evening over the introductory chapter of this School Algebra without getting more than a general idea of what it is about. And if this is true of one of the best school algebras ever written, it must mean that the subject is one of great difficulty, unless you choose to accept Sir William Hamilton's comforting assurance, that "to minds of any talent, mathematics are only difficult because they are too easy."

Would it not be possible to aid the secondary school by some "let up" in the college entrance requirements? Suppose arithmetic only should be required in school and the difficult subjects of algebra and geometry postponed to the maturer years of college. I take it that in a thorough and long-sustained study of arithmetic between the ages of ten and seventeen, a boy might acquire an understanding of its principles and considerable facility in applying them. He might also, by a long study and use of applied arithmetic, gain a great deal of useful information about numerical relations in the world in which he lives and a truer appreciation of the importance of mathematical values and conceptions. If he subsequently went to college, would he not then be far better fitted for such studies as algebra and geometry? And if he did not go to college, would he not have derived quite as much benefit from the study of mathematics as he now derives during his course at school? He would have traveled a much shorter journey, but would he not have learned the road much better? It is your pedestrian, and not the automobilist, who really *sees* the country. And would he not have gained more in *mental power?* Would he not have seen the difference between learning a thing and understanding it; between *seeming* and *being?* Would he not have gotten a glimmer of what Hobbes meant when he said that "words are the counters of wise men, but the money of fools"? Would he not have learned to plant his feet upon the ground and perhaps grow some day to a realization of Lord Bacon's noble saying that "no pleasure is comparable to the standing upon the vantage ground of truth"

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